CLAIMS

What is claimed is:

1. A solid-state laser module for amplification of laser radiation comprising:

a substrate having a front surface and a back surface, said front surface of said substrate having a plurality of channels formed therein;

a plurality of laser gain medium elements, each of said laser gain medium elements having a front surface, a back surface, and a peripheral edge surface, said back surfaces of said laser gain media being in contact with said front surface of said substrate;

a source of optical pump radiation for directing optical pump radiation into said plurality of laser gain medium elements;

wherein said channels are maintained at a reduced pressure such that a pressure differential is created between said front surface and said back surface of said laser gain medium to thereby maintain said laser gain medium secured against said front surface of said substrate;

wherein each of said plurality of laser gain medium elements are placed closely adjacent one another such that a peripheral edge of each is positioned closely adjacent a peripheral edge of another one of said laser gain medium elements; and

wherein at least one of said laser gain medium elements has an optical coating on said back surface thereof to provide high reflectivity at a lasing wavelength of said laser gain media;

wherein at least one of said laser gain medium elements has an optical coating on said front surface thereof, said coating being antireflective at a lasing wavelength of said laser gain medium element; and

wherein said substrate is cooled.

2. The laser module of claim 1, further comprising a cooling medium flowing through said channels for cooling said laser gain media.

3. The laser module of claim 1, wherein said laser gain media comprises a host lattice, and wherein said host lattice and said undoped optical medium are selected from the group consisting of yttrium aluminum garnet, gadolinium gallium garnet, gadolinium scandium gallium garnet, lithium yttrium fluoride, yttrium vanadate, phosphate glass, silicate glass, and sapphire.

4. The laser module of claim 3, wherein said host lattice is doped with a material selected from the group of Ti, Cu, Co, Ni, Cr, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm and Yb.

5. The laser module of claim 1, wherein said source of optical pump radiation is comprised of at least one semiconductor diode laser.

6. The laser module of claim 1, wherein a material suitable for absorption of amplified spontaneous emission (ASE) is affixed to at least one part of a peripheral edge of at least one of said laser gain medium elements.

7. The laser module of claim 6, wherein said material suitable for absorption of amplified spontaneous emission is affixed to said edge by means chosen from the group consisting of adhesive bonding, diffusion bonding, fusion bonding, and optical contacting followed by heat treatment.

8. The laser module of claim 6, wherein at least two of said laser gain medium elements are bonded along their adjacent edges with said material suitable for absorption of amplified spontaneous emission therebetween; and

wherein said bond is produced by a method chosen from a group consisting of fusion bonding, diffusion bonding, and optical contacting followed by a heat treatment.

9. The laser module of claim 1, wherein said optical pump radiation is directed into said front surface of at least one of said laser gain media elements.

10. The laser module of claim 1, wherein said substrate is fabricated from material transparent the wavelengths of said optical pump radiation; and

wherein said optical pump radiation is injected through said substrate into said back surface of at least one of said laser gain media elements.

11. The laser module of claim 1, further including an undoped optical medium attached to said peripheral edge of said laser gain media elements;

wherein said optical pump radiation is directed into said undoped optical medium, said undoped optical medium transporting said optical pump radiation into an associated one of said laser gain media elements; and

wherein said undoped optical medium is secured to said peripheral edge via a bond which is transparent at a wavelength of said optical pump radiation and a lasing wavelength of said laser gain media.

12. The laser module of claim 11, further comprising at least one tapered duct for concentration of said optical pump radiation, said tapered duct being interposed between said undoped optical medium and said source of optical pump radiation for directing said optical pump radiation toward said undoped optical medium.

13. The laser module of claim 1, wherein said laser gain medium comprises a non-planar shape.

14. A solid-state laser module comprising:

a) a rigid substrate having a plurality of internal passages forming channels within a support surface of said rigid substrate, said passages leading up to the surface of said substrate and being maintained at a substantially lower pressure than an atmosphere in which said laser module is immersed;

b) a plurality of laser gain medium elements disposed closely adjacent one another and against said support surface, each of said laser gain medium effectively having a pair of surfaces having a first dimension, said pair of surfaces further being opposite to each other and being separated by a peripheral edge surface, each of said laser gain medium having a thickness representing a second dimension which is substantially smaller than said first dimension;

i) a first one of said pair of surfaces including an anti-reflection coating which is substantially totally transmissive of radiation at a wavelength at which laser gain is produced therein;

ii) said second surface of said pair of surfaces including a coating which is substantially totally reflective of radiation at a laser gain wavelength;

iii) said second one of said pair of surfaces being disposed against said support surface of said substrate and maintained so by a pressure differential between pressure in said passages and said atmosphere in which said laser module is immersed; and

at least one source of optical pump radiation directing optical pump radiation into at least one of said laser gain medium elements.

15. The laser module of claim 14, wherein said pressure differential is sufficiently high for said laser gain media to conform to the shape of said support surface.

16. The laser module of claim 14, wherein said substrate is cooled.

17. The laser module of claim 14, further comprising a cooling medium flowing through said channels for cooling at least one of said laser gain medium elements.

18. The laser module of claim 14, wherein a material suitable for absorption of amplified spontaneous emission (ASE) is affixed to at least one part of a peripheral edge of at least one of said laser gain medium elements.

19. The laser module of claim 14, wherein said sources are arranged for directing optical pump radiation into at least one said peripheral edge of at least one of said laser gain medium elements.

20. The laser module of claim 19, further comprising at least one tapered optical duct disposed between at least one of said sources of optical pump radiation and said peripheral edge, said tapered optical duct concentrating said optical pump radiation into said peripheral edge of said at least one laser gain medium element.

21. The module as in claim 19, further comprising at least one undoped optical medium affixed to said peripheral edge of said laser gain medium elements via an optically transparent bond, said undoped optical medium conveying said optical pump radiation into said peripheral edge.

22. The laser module of claim 14, wherein said sources are arranged for directing optical pump radiation into the first surface of said pair of surfaces of at least one of said laser gain medium elements.

23. The laser module of claim 14, wherein said substrate is fabricated from material transparent at the wavelengths of said optical pump radiation; and

wherein said sources are arranged for directing optical pump radiation through said substrate into the second surface of said pair of surfaces of at least one of said laser gain medium elements.

24. The laser module of claim 18, wherein at least two of said laser gain medium elements are bonded along their adjacent edges with said material suitable for absorption of amplified spontaneous emission therebetween; and

wherein said bond is produced by a method chosen from a group consisting of fusion bonding, diffusion bonding, and optical contacting followed by a heat treatment.

25. The laser module of claim 19, further comprising at least one lensing element disposed between at least one of said sources of optical pump radiation and said peripheral edge, said lensing element concentrating said optical pump radiation into said peripheral edge of said laser gain medium.

26. A solid-state laser module comprising:

a) a cooled rigid substrate

b) at least one laser gain medium element disposed closely adjacent one another and against said support surface, each of said laser gain medium effectively having a pair of surfaces having a first dimension, said pair of surfaces further being opposite to each other and being separated by a peripheral edge surface, each of said laser gain medium having a thickness representing a second dimension which is substantially smaller than said first dimension;

i) a first one of said pair of surfaces including an anti-reflection coating which is substantially totally transmissive of radiation at a wavelength at which laser gain is produced therein;

ii) said second surface of said pair of surfaces including a coating which is substantially totally reflective of radiation at a laser gain wavelength;

iii) said second one of said pair of surfaces being attached to said support surface of said substrate and maintained so by a bonded joint; and

at least one source of optical pump radiation directing optical pump radiation into at least one of said laser gain medium elements.

27. The laser module of claim 26, wherein said bonded joint is produced by optical contacting followed by heat treatment.

28. The laser module of claim 26, wherein said bonded joint is produced by a method selected from a group comprising soldering, brazing, and adhesive bonding.

29. The laser module of claim 26, further comprising channels formed within said support surface and a cooling medium flowing through said channels for cooling at least one of said laser gain medium elements.

30. The laser module of claim 26, wherein a material suitable for absorption of amplified spontaneous emission (ASE) is affixed to at least one part of a peripheral edge of at least one of said laser gain medium elements.

31. The laser module of claim 26, wherein said sources are arranged for directing optical pump radiation into at least one said peripheral edge of at least one of said laser gain medium elements.

32. The module as in claim 31, further comprising at least one undoped optical medium affixed to said peripheral edge of said laser gain medium elements via an optically transparent bond, said undoped optical medium conveying said optical pump radiation into said peripheral edge.

33. The laser module of claim 26, wherein said sources are arranged for directing optical pump radiation into the first surface of said pair of surfaces of at least one of said laser gain medium elements.

34. The laser module of claim 26, wherein said substrate is fabricated from material transparent at the wavelengths of said optical pump radiation; and

wherein said sources are arranged for directing optical pump radiation through said substrate into the second surface of said pair of surfaces of at least one of said laser gain medium elements.